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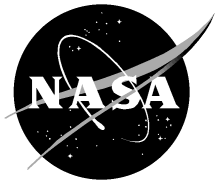

SeaWiFS Postlaunch Technical Report Series

Stanford B. Hooker, Editor
NASA Goddard Space Flight Center, Greenbelt, Maryland

Elaine R. Firestone, Senior Scientific Technical Editor
Science Applications International Corporation, Beltsville, Maryland

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Ray Barlow, Heather Sessions, Nonkqubela Silulwane, and Hermann Engel
Marine and Coastal Management, Cape Town, South Africa

Stanford B. Hooker
NASA Goddard Space Flight Center, Greenbelt, Maryland

James Aiken, James Fishwick, and Victor Martinez-Vicente
Plymouth Marine Laboratory, Plymouth, United Kingdom

André Morel, Malik Chami, and Joséphine Ras
LOV Observatoire Océanologique de Villefranche, Villefranche-sur-Mer, France

Stewart Bernard and Maya Pfaff
University of Cape Town, Cape Town, South Africa

James W. Brown
RSMAS University of Miami, Miami, Florida

Alexandra Fawcett
Saturn Solutions, Ltd., Southampton, United Kingdom

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Abstract

This report documents the scientific activities on board the South African Fisheries Research Ship (FRS) *Africana* during an ocean color calibration and validation cruise in the Benguela upwelling ecosystem (BENCAL), 4–17 October 2002. The cruise, denoted *Africana* voyage 170, was staged in the southern Benguela between Cape Town and the Orange River within the region 14–18.5°E,29–34°S, with 15 scientists participating from seven different international organizations. Uniquely in October 2002, four high-precision ocean color sensors were operational, and these included the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on the Aqua and Terra spacecraft, the Medium Resolution Imaging Spectrometer (MERIS), and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS). SeaWiFS imagery was transmitted daily to the ship to assist in choosing the vessel's course and selecting stations for bio-optical deployments. There were four primary objectives of the cruise. The first was to conduct bio-optical measurements with above- and in-water optical instruments to vicariously calibrate the satellite sensors. The second was to interrelate diverse measurements of the apparent optical properties (AOPs) at satellite sensor wavelengths with inherent optical properties (IOPs) and bio-optically active constituents of seawater such as particles, pigments, and dissolved compounds. The third was to determine the interrelationships between optical properties, phytoplankton pigment composition, photosynthetic rates, and primary production, while the fourth objective was to collect samples for a second pigment round-robin intercalibration experiment. Weather conditions were generally very favorable, and a range of hyperspectral and fixed wavelength AOP instruments were deployed during daylight hours. Various IOP instruments were used to determine the absorption, attenuation, scattering, and backscattering properties of particulate matter and dissolved substances, while a Fast Repetition Rate Fluorometer (FRRF) was deployed to acquire data on phytoplankton photosynthetic activity. Hydrographic profiling was conducted routinely during the cruise, and seawater samples were collected for measurements of salinity, oxygen, inorganic nutrients, pigments, particulate organic carbon, suspended particulate material, and primary production. Location of stations and times of optical deployments were selected to coincide with satellite overpasses whenever possible, and to cover a large range in trophic conditions.

1. INTRODUCTION

The Benguela Current flows along the west coast of southern Africa and is one of four major eastern boundary current systems in the world ocean. The oceanography of the region is dominated by coastal upwelling and the Benguela Current is unique in that it is bounded on both the poleward and equatorward ends by warm water regimes (Nelson and Hutchings 1983, Shannon 1985, and Shannon and Nelson 1996). The Benguela ecosystem (14–37°S) displays substantial seasonal, interannual, and decadal variability which significantly impact its biological resources. The northern boundary of the Benguela ecosystem, the Angolan–Benguela frontal zone, is a permanent feature and characteristically maintained between 14–17°S. The southern boundary is considered to be the Agulhas retroflection area between 36–37°S. This warm boundary moves during the year, and tropical Agulhas water *leaks* into the South Atlantic, mostly in the form of eddies and filaments, which are shed from the Agulhas Current as it retroflects to the east (Duncombe Rae 1991, Nelson et al. 1998, and Garzoli et al. 1999).

The extent and intensity of coastal upwelling throughout the Benguela is primarily determined by the wind and pressure fields, and together with topographic features and the orientation of the coast, results in the formation of a number of upwelling cells (Nelson and Hutchings 1983, Hutchings 1992, and Shannon and Nelson 1996). The largest cell, located off Luderitz, is characterized by high turbulence and is one of the most intense upwelling cells in the world ocean. Upwelling in the south tends to be more ephemeral and seasonal. Between 18–34°S, there is a well-developed longshore thermal front, or series of fronts, which coincides approximately with the seaward boundary of the general upwelling area (Shannon and Nelson 1996). South of Luderitz, a single front is usually well defined, which although spatially and temporally variable, coincides approximately with the shelf edge. Farther north, the front is more diffuse and multiple fronts are sometimes evident. Upwelling filaments, with a life span of days to several weeks, and generally orientated perpendicular to the coast, cause the front to become highly convoluted (Shannon and Nelson 1996).

As a consequence of upwelling, primary production is high. Average primary production estimates for the northern Benguela are $1.2\,\mathrm{gC\,m^{-2}\,d^{-1}}$ and $2.0\,\mathrm{gC\,m^{-2}\,d^{-1}}$ for the southern Benguela (Brown et al. 1991). The phytoplankton communities are generally dominated by diatoms, although some studies have highlighted the importance of nanoflagellates (Mitchell-Innes and Winter 1987,